One DoF micro-nano-force sensor using diamagnetic levitation

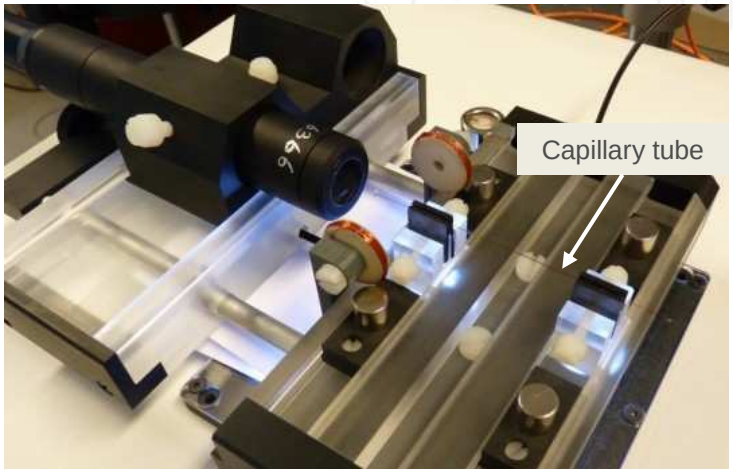
Research framework

When high bandwidth in micro and nano force measurement is not mandatory, the use of rigid *macroscopic* force-displacement transducers is a possible alternative to force sensors based on elastic microstructures. Sensors using such transducer are easy to produce using conventional assembly approaches and also easy to handle thanks to the size of the transducer. The SPECIMeN group is developing such sensors characterized by high resolution and long range force measurement using passive stable *magnetic springs* resulting from the combination of attractive magnetic forces coupled with a repulsive physical principle (diamagnetic repulsion).

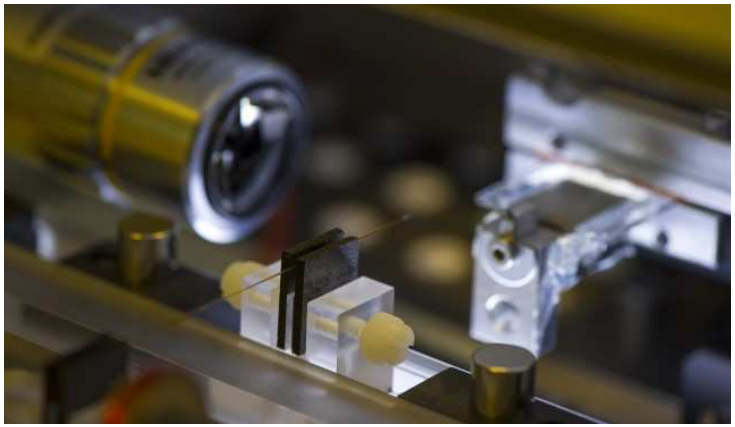
Sensor characteristics

Macroscopic force-displacement transducer: 10-cm long capillary tube (20 to 80 mg).
Force measurement: along the capillary longitudinal axis.
Adjustable stiffness: 0.005 N/m to 0.03 N/m.
Resolution: 1 to 5 nN (1)
Max range: ± 50 µN typ. (2)
Displacement bandwidth: 4 Hz typ. (3)
Max force bandwidth: 15 Hz typ. (1)
Displacement measurement: confocal chromatic sensors.
Response: under-damped second-order linear force-displacement dynamic.

(1) depends on the S/N ratio wanted on force measurements and the resolution of the displacement sensor.
(2) depends on the range measurement of the displacement sensor used.
(3) depends on the mass of the capillary tube.



Capillary tube in diamagnetic levitation



Zoomed view to the capillary tube

Major article: J. Abadie, E. Piat, S. Oster, M. Boukallel, Modeling and experimentation of a passive low frequency nanoforce sensor based on diamagnetic levitation, Sensors and Actuators: A Physical, 2012, 173(1):227-237.

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SPECIMeN Group

Sensing strategies, Perception and Characterization at Micro- and Nano-scales

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